Absorbent sanitary articl for absorbing body fluid

This invention relates to an absorbent sanitary article for absorbing body fluids which comprises a matrix containing metallic silver.

An absorbent sanitary article of the aforementioned kind is known from EP 1 066 825 A1. The sanitary article described therein typically comprises a solid matrix consisting of pulp in particular. Saturated with body fluid, the matrix constitutes a good substrate for a number of microorganisms. The growth of such microorganisms can give rise to sanitary and medical problems. It may lead to the development of unpleasant odors in particular.

The sanitary articles known from EP 1 066 825 A1 tackle this problem by including an organic matrix which contains homogeneously disbursed silver particles. The silver particles in question are from 1 to 50 nm in size. They are capable of releasing antimicrobially and fungicidally active silver ions. However, there is a problem in that at a high concentration silver ions also have a toxic effect on cells of human skin or mucosa. The silver particles in the sanitary article of EP 1 066 825 may be included in a solid or liquid organic matrix. The liquid organic matrix may be an oily liquid with which the sanitary product is treated. The disadvantage with this process is that the silver comes to be deposited in the sanitary article in a nondefined manner. The process may cause different amounts of silver particles to be utilized at a varying distance from the surface of the sanitary article. Consequently, the concentration of silver ions which is active at the surface of the sanitary article will also vary in use. Silver ion concentration at the surface may thus be high and hence cytotoxic effects may occur. It is further known that silver ions which have penetrated into a tissue or into a mucosal membrane may

affect cell growth. This effect is undesirable for a sanitary article.

A further disadvantage of a liquid organic matrix is that silver particles may be flushed into deeper layers of the sanitary article in use of the sanitary article, so that it is no longer possible for the surface of the sanitary article to achieve an antimicrobially active silver ion concentration. This risk is particularly acute when large amounts of fluid have to be absorbed by the sanitary article, as in the case of diapers for example.

The solid organic matrix may be a polymer in which silver particles have been dispersed. Silver ion formation, however, is possible only from silver particles which are not fully encapsulated by the polymer and hence are accessible to the fluid. Consequently, more silver has to be incorporated into the polymer than is ultimately available for forming silver ions. The polymer has a further disadvantage in that those silver particles in the polymer which are inaccessible to the fluid may become haphazardly accessible to the fluid when the polymer becomes brittle or crumbly. Relatively large amounts of silver ions may then be unintentionally released, so that cytotoxic effects may occur.

It is an object of the present invention to remedy prior art disadvantages. More particularly, a sanitary article containing metallic silver shall be provided that permits a more constant silver ion concentration at its body-facing surface in use for the duration of the typical use than sanitary articles known from EP 1 066 825 A1. It is a further object of the present invention to provide a sanitary article where the concentration of silver ions at any one of its body-facing surfaces in use of the sanitary article is kept so low that silver ions cannot pass into tissue or

mucosa in an amount in which they would affect cell growth there.

This object is achieved by the features of claims 1 and 15. Advantageous embodiments result from the features of claims 2 to 14 and 16 to 29.

According to the invention there is provided an absorbent sanitary article for absorbing body fluids which comprises a matrix containing metallic silver, wherein the silver is present bound to a fiber exclusively on the surface thereof. Bound is to be understood as meaning that the metallic silver is chemically or physically attached to the surface such that it cannot be flushed away from the fiber in use of the sanitary article. Attachment may be via charges for example. A suitable silver-coated fiber is available for example from Statex Produktions- + Vertriebs GmbH, Querlandstr. 6b, 28357 Bremen, Germany. Surprisingly, the desired antimicrobial and fungicidal effects are achievable with the inventive sanitary article at very low levels of silver. The immobilization of the metallic silver on the fiber makes it possible for the metallic silver to be disposed at a defined location within the sanitary article. This makes it possible to achieve a defined maximum silver ion concentration on the sanitary article surface which faces the body in use. Since the metallic silver is situated only at the surface of the fiber, the manufacturing process does not have to utilize an unnecessary amount of metallic silver which ultimately is completely surrounded by a polymer and thus is not accessible to body fluid.

Advantageously, the metallic silver is attached in depressions in the surface of the fiber, especially hind-grippedly. Such a fiber is available from Statex Produktions- + Vertriebs GmbH.

Preferably, the fiber is a synthetic fiber. The

synthetic fiber may be a polyamide, such as nylon-6,6 or nylon-6, a polyester, such as Dacron, Diolen or Trevira, a polyacrylic, such as acrylic, Dralon, Dolan or Orlon, an elastane, such as Dorlastan or Lycra, or a polychloride, such as Movil or Rhovyl.

The fiber may be present in the form of a woven, in the form of a nonwoven or in the form of a thread. A thread may be a twisted fiber for example. An advantage here would be that the fiber is as a result easier to dispose at a defined location within the absorbent sanitary article. Suitable silver-containing wovens are likewise available from Statex Produktions- + Vertriebs GmbH. Such wovens are typically used for electrical screening and for producing conductive floors.

In a preferred embodiment, the fiber has a weight-based silver content of not more than 3%. This has the advantage that any cytotoxic effect and undesirable side-effects can be substantially ruled out. A further advantage is that the low silver content allows for a more skin-colored coloration of the fiber. The fiber surface would be metallically shiny at high silver contents. As a result, the sanitary article would be undesirably visible through light clothes.

Preferably, the silver content of the fiber is just high enough to ensure that an antimicrobial effect is detectable on a first body contact surface of the sanitary article for not more than 24 hours in particular. The requisite silver content is dependent inter alia upon the material of the fiber and upon the size of the metallic silver surface area accessible to body fluid. To detect the effect, the sanitary article is moistened with an amount of liquid which the sanitary article would typically absorb when put to its intended use. Preferably, the metallic silver is present in the form of bound particles from 1 to 30 nm, preferably from 1 to 10 nm and especially from 1 to

6 nm in diameter. The smaller the particles, the larger the surface area of the metallic silver. Any desired silver ion release is achievable with smaller particles at a lower amount of silver on account of the overall larger surface area.

In a preferred embodiment, the metallic silver fully surrounds the outer surface of the fiber. However, the outer surface is to be understood as not including the ends of the fiber which are bared by a cut through the fiber for example and which can each be free of silver. Such a fiber is available for example from Statex Produktions- + Vertriebs GmbH. Such a fiber has the advantage that the silver is particularly firmly adherent thereto.

In a preferred embodiment, the fiber, the woven, the nonwoven or the thread is present within the sanitary article in piecewise disbursement. The pieces in question have such a size that they are not flushed away by body fluid in the customary use of the sanitary article. Preferably, the fiber, the woven, the nonwoven or the thread is disposed within a layer of the sanitary article. In the case of a tampon, for example, this layer may be provided through a rolled woven within the tampon. As a result of the layer having a defined distance from the first surface, the position and the silver content of the layer can be used to determine the silver ion concentration which is possible at the first surface. Advantageously, the layer is disposed closer to the first surface of the sanitary article than to a second surface which is not intended for body contact, especially closer to the first surface than to the midpoint between the first surface and the second surface. The closer the layer is disposed to the first surface, the lower the silver contents which are sufficient for an antimicrobial and fungicidal effect on the first surface. On the other hand, disposition directly at the first surface will

increase the risk that silver ions will enter a tissue or a mucosa and lead to undesirable side-effects there.

Preferably, the sanitary article contains a pulp and/or a superabsorbent. The sanitary article may be a disposable article. The disposable article may be a diaper, especially a pants-type diaper, a training pant, an incontinence pad or a feminine hygiene article, especially a sanitary napkin, a panty liner or a tampon. A training pant is an absorbent underpant worn by children undergoing toilet training.

The invention further provides a process for producing an absorbent sanitary article for absorbing body fluids which comprises a matrix containing metallic silver, which comprises the silver being bound to a fiber exclusively on the surface thereof. The silver may be applied to the fiber by electro, chemical or electrochemical deposition or by vapor deposition. Preferably, the silver is bound to the fiber by means of a chemical or physical bond. This may take the form of electrical charges for example. Similarly, lodging and attachment in fiber crypts is possible. Preferably, the metallic silver is attached in depressions in the surface, especially hind-grippedly. The surface of the fiber may be mordanted prior to the binding of the silver. Mordanting is where the surface is chemically modified, by means of a gas or liquid, in such a way that it is suitable for binding silver.

The fiber used is preferably a synthetic fiber. This synthetic fiber may contain in particular a polyamide, a polyester, a polyacrylic, an elastane or a polychloride. Preferably, the fiber is incorporated in the sanitary article in the form of a woven, in the form of a nonwoven or in the form of a thread.

In a preferred embodiment, the silver is applied up to a 3% silver content of the fiber. It is particularly

advantageous to apply the silver only up to a silver content of the fiber just high enough to ensure that an antimicrobial effect is detectable on a first body contact surface of the sanitary article for not more than 24 hours in particular. The metallic silver may be bound in the form of particles from 1 to 30 nm, preferably from 1 to 10 nm and especially from 1 to 6 nm in diameter.

It is particularly advantageous for the metallic silver to be applied such that the outer surface of the fiber is fully surrounded by silver. But the ends of the fiber, for example, due to a cut through the fiber, may be free of silver. The ends are not outer surface for the purposes of the present invention.

The fiber, the woven, the nonwoven or the thread may be disbursed within the matrix of the sanitary article in piecewise form. Preferably, the woven, the nonwoven or the thread is disposed within a layer of the sanitary article. The layer is disposed closer to the first surface of the sanitary article than to a second surface which is not intended for body contact, especially closer to the first surface than to the midpoint between the first surface and the second surface. Preferably, a pulp and/or a superabsorbent is incorporated in the sanitary article.

The invention will now be more particularly described with references to operative examples and the drawings, where

figs. 1a and b show a schematic sectional depiction through a sanitary napkin having a layer of a silverized woven,

fig. 2 shows a schematic sectional depiction through a sanitary napkin having a silverized fiber present therein in

piecewise disbursement,

fig. 3 shows a schematic perspective depiction of a tampon having silverized woven tapes passing therethrough,

fig. 4 shows a schematic perspective depiction of a tampon containing a silverized rolled woven ply,

fig. 5 shows a schematic sectional depiction of a cross section through a tampon having a silverized rolled woven ply, and

fig. 6 shows a graphic depiction of the growth of bacteria on a silverized woven and on a woven without silver.

Fig. 1a schematically depicts in cross section a sanitary napkin 10 which has a first body contact surface 12 and a second nonbody contact surface 14. The second surface 14 has been provided with an adhesive strip 16 which permits fastening, for example in a pair of panties. A layer of a silver-containing woven 18 is disposed in the center of the sanitary napkin. The woven 18 consists of nylon-6,6 fibers having silver bound to their surface.

Fig. 1b shows a cross section through a similarly constructed sanitary napkin where the layer of the silverized woven 18 is disposed in the vicinity of the first surface 12. A silver ion concentration which is antimicrobially active at the first surface 12 can with this arrangement be achieved at a lower silver content than in the case of the sanitary napkin 10 as per fig. 1a. This is because the silver ions released by the woven have to overcome a shorter diffusion path to get to the first surface 12. The advantage of the

arrangement as per fig. 1a, in contrast, is that a sufficiently high silver ion concentration to reliably prevent the growth of microorganisms is more likely to be achievable in the entire sanitary napkin even on absorption of a larger amount of fluid.

Fig. 2 shows a schematic depiction of a cross section through a sanitary napkin having a first surface 12, a second surface 14 and an adhesive strip 16. The portion which has been magnified is a schematic depiction of the composition of a matrix forming the filling of the sanitary napkin. The matrix contains pulp fibers 20, superabsorbents 22 and a silverized fiber 24 present therein in piecewise disbursement.

Fig. 3 shows a schematic perspective depiction of a tampon 26 having a first surface 12. This tampon 26 has narrow tapes of a silverized woven 18 passing through it.

Fig. 4 shows in schematic form a perspective depiction of a tampon 26 having a first surface 12, this tampon 26 containing a rolled silverized woven 18.

Fig. 5 shows in schematic form a cross section through a conically shaped tampon 26 having a first surface 12 and a rolled silverized woven 18 included therein.

The antimicrobial effect has been examined as per the method described in Bechert et al., NATURE MEDICINE Vol. 6 Issue 9, September 2000, pages 1053-1056, by means of bacteria of the type Staphylococcus epidermidis on a silverized woven and, for comparison therewith, on a woven without silver. The woven is a nylon-6,6 woven from Statex Produktions- + Vertriebs GmbH. In this woven, the silver is immobilized on the surface of the nylon-6,6 fiber.

Fig. 6 shows the line 28 of the time course of the

bacterial growth on the silverized woven. The time course of bacterial growth on the woven without silver is depicted by line 30. The growth took place under almost physiological conditions in a phosphate-buffered salt solution. The line 28 shows complete inhibition of bacterial growth by the silverized woven.